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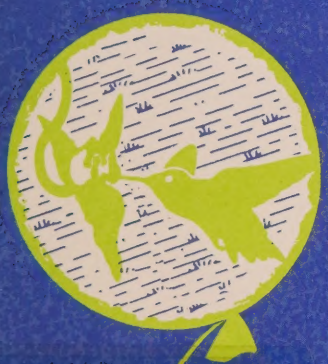
SCIENCE IS HAPPENING HERE

Ministry of Education
Ontario

Chris Ward, Minister
Bernard J. Shapiro, Deputy Minister

A Policy Statement for Science in the Primary and Junior Divisions

1988



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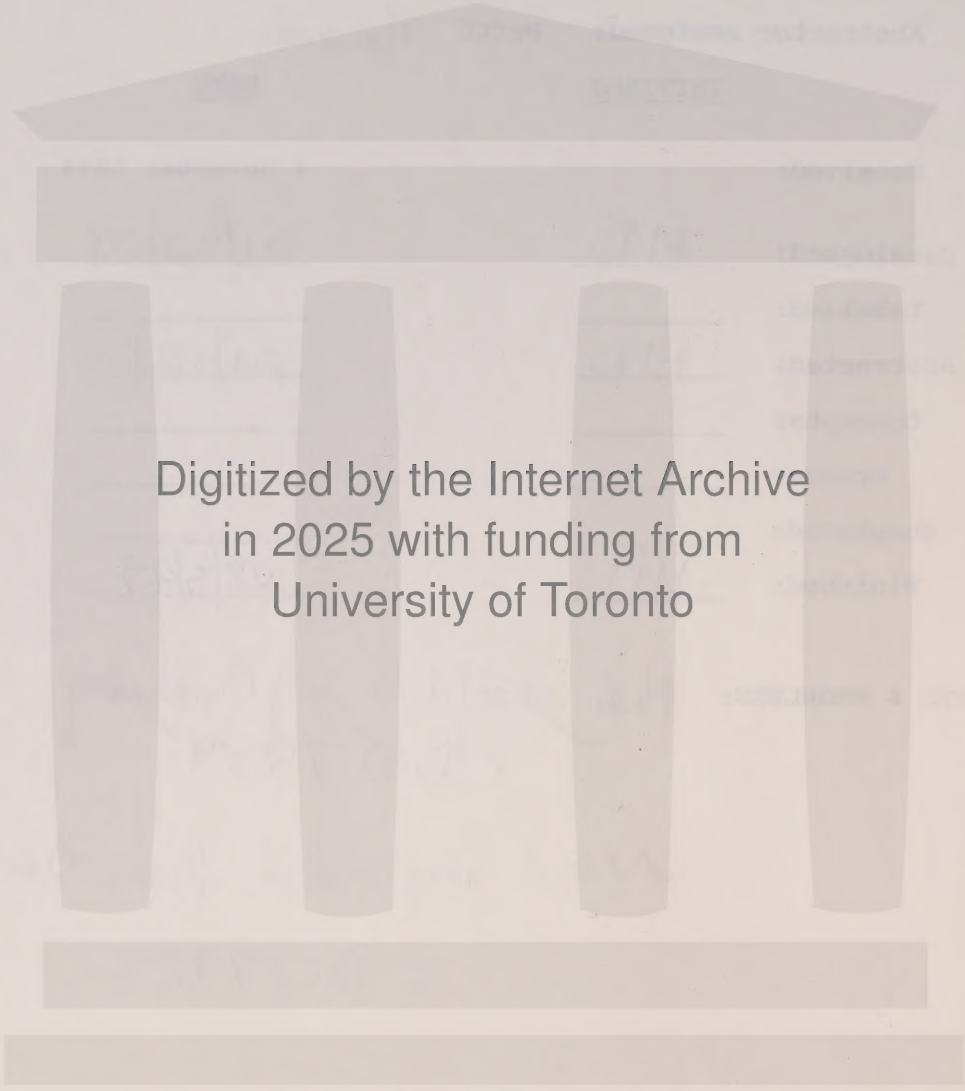

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Preface

This document outlines Ministry of Education policy for the development of the science component of the curriculum for the Primary and Junior Divisions. The policy supports and extends Ontario's goals for education and the aims for science stated in the environmental studies section of *The Formative Years.*[1] The expectations outlined in *Science Is Happening Here: A Policy Statement for Science in the Primary and Junior Divisions* shall be used by school boards in developing local programs.

Ontario's Goals of Education

The policy described in this document supports the attainment of the goals of education established for the Province of Ontario, which are to help each child to:

1. develop a responsiveness to the dynamic processes of learning;
2. develop resourcefulness, adaptability, and creativity in learning and living;
3. acquire the basic knowledge and skills needed to comprehend and express ideas through words, numbers, and other symbols;
4. develop physical fitness and good health;
5. gain satisfaction from participating and from sharing the participation of others in various forms of artistic expression;
6. develop a feeling of self-worth;
7. develop an understanding of the role of the individual within the family and the role of the family within society;
8. acquire skills that contribute to self-reliance in solving practical problems in everyday life;
9. develop a sense of personal responsibility in society at the local, national, and international levels;
10. develop esteem for the customs, cultures, and beliefs of a wide variety of societal groups;
11. acquire skills and attitudes that will lead to satisfaction and productivity in the world of work;
12. develop respect for the environment and a commitment to the wise use of resources;
13. develop values related to personal, ethical, or religious beliefs and to the common welfare of society.

1. Ministry of Education, Ontario, *The Formative Years: Provincial Curriculum Policy for the Primary and Junior Divisions of the Public and Separate Schools of Ontario* (Toronto: Ministry of Education, Ontario, 1975), p. 22.

Introduction

The experiences of children in the Primary and Junior Divisions must be relevant to them on an immediate and personal level and at the same time provide a foundation for their participation in a changing world. It is the responsibility of educators to provide science experiences that will encourage children to develop attitudes, skills, and knowledge that they can use both today and in the future. In keeping with this practical approach, science education in the Primary and Junior Divisions includes the world of technology.

Learning through and about science and technology in an active manner allows and encourages children to explore their environment, ask questions, generate and test ideas, evaluate, and create. Exercise of these skills will help children to strengthen and deepen their reasoning abilities and to become self-motivated, independent learners and active, concerned participants in society.

Involvement in the science and technology component of the educational program will help and encourage children to:

- appreciate the beauty and value of their natural environment;
- respond constructively to changes effected through science and technology;
- develop a positive attitude towards the conservation of natural resources;
- develop the attitudes, skills, and knowledge required to make informed decisions;
- enhance their self-concepts through their understanding of the environment;
- appreciate the scientific and technological contributions of Canadians;
- see the relationship of science to other areas of learning;
- feel competent, and therefore self-confident, in a society that uses and is influenced by science and technology.

Through science, children seek to discover and explain patterns and relationships in what they observe. Children learn about their physical and natural environments and acquire confidence in their scientific ability as they:

- play and explore;
- investigate, experiment, and discover;
- ask questions and seek solutions;
- look for applications of science;
- create, invent, and construct;
- explore and use technology;
- relate science to their own and others' needs.

The Learner and the Learning Environment

The Learner

Each child should be viewed as "an active participant in education who gains satisfaction from the dynamics of learning" and as a "self-motivated, self-directed problem-solver . . . deriving a sense of self-worth and confidence from a variety of accomplishments".[2]

The dynamics of learning include active involvement in playing, working, exploring, creating, taking risks, planning and initiating, asking questions, seeking solutions, and reflecting, both independently and with others. Interaction with others provides opportunities for recognition and acceptance. The most important measure of success, however, is the learner's own sense of achievement.

Science is important for all learners, but the uniqueness of each learner must be acknowledged. Varied backgrounds and special learning needs affect the ways in which children will participate in science.

Special Needs

Children with special needs, including exceptional children, should participate as actively as possible in all learning opportunities provided. Educators must be prepared to adapt the physical environment, the teaching strategies, and the evaluation procedures to accommodate the intellectual, emotional, and physical requirements of the children. The kind, breadth, depth, and pace of learning experiences provided for children should correspond to their needs, abilities, and interests. Such matching makes it possible for all children to experience success.

These considerations are particularly important when children are exceptional in behavioural, communicative, intellectual, and/or physical functioning. The learning environment must accommodate the special learning needs and abilities of these children as identified by a school board's Identification, Placement, and Review Committee. Ministry of Education publications contain suggested teaching strategies for children with various exceptionalities.[3]

2. Ministry of Education and Ministry of Colleges and Universities, Ontario, *Issues and Directions: The Response to the Final Report of the Commission on Declining School Enrolments in Ontario* (Toronto: Ministry of Education and Ministry of Colleges and Universities, Ontario, 1980), p. 2.

3. *Children With Physical Handicaps and Health Impairments* (1978); *Vision* (1987); *Children With Communication Exceptionalities* (1979); *Children With Mild Intellectual Handicaps* (1979); *Children With Moderate and Severe Intellectual Handicaps* (1981); *Learning Disabilities* (1987); *Programming for the Gifted* (1985); *Behaviour* (1986).

Multiculturalism

The uniqueness of each child in Ontario is often related to the multicultural nature of Canadian society. A learning environment that celebrates cultural, linguistic, racial, and religious diversity will help children develop an understanding of interrelationships and an open-minded attitude. Both are basic to scientific inquiry.

Sex Equity

If all children are to realize their full potential, it is essential that girls and boys participate equally in science. A conscious effort must be made to involve and encourage all children in the full range of learning opportunities, roles, and activities in science (including planning, recording, reporting, setting up experiments, using equipment, maintaining safety awareness, and tidying up work areas).

When teachers consciously model an interest and involvement in science, they motivate children to become involved and to view themselves as capable of participating in science. Inviting both women and men to share their science experiences with the class will help children to view science as a field of interest and endeavour appropriate for everyone. All resources (human, print, audio-visual) chosen for use in the classroom should be bias-free and support all children's involvement in science.

The Learning Environment

The learning environment should reinforce the image of the learner as an active, enthusiastic, and unique participant in the learning process. In order to do so, it must:

- offer children opportunities for direct observation and hands-on experiences with a variety of appropriate, current, and motivating materials;
- offer children opportunities for interaction with peers and adults;
- encourage safe practices;
- accommodate both child-initiated and teacher-selected learning experiences;
- meet the changing needs, abilities, interests, and learning styles of children;
- give children time, space, and encouragement to explore freely, to reflect, and to consolidate learning;
- allow the teacher and the children to capitalize on incidental events that occur spontaneously in the course of an investigation;
- extend beyond the classroom to include the outdoors and other components of the child's environment.

The Role of the Teacher

Children are most willing to become involved in science if the teacher, modelling inquiry as an active participant, demonstrates a willingness to learn with and from the children. Teachers should listen to and observe, as well as guide, the investigations of each child. During these investigations, the teacher should assist the children in recognizing that they are doing science.

The teacher should encourage free exploration of science materials and concepts within a carefully managed environment. Exploration of materials and concepts should lead to investigations that involve the student in critical thinking and the skills of science. If they are to explore and investigate freely, children need to be assured that risk taking and unforeseen outcomes are valuable components of scientific endeavours and important parts of the learning process. This assurance is provided by a sensitive, supportive environment in which creativity is encouraged. Some questions designed to guide teachers in developing an environment conducive to science learning are presented in Appendix A.

Grouping

Opportunities for whole-class, small-group, and individual activities aid in accommodating the broad range of children's interests, talents, and needs.

Individual activity gives children opportunities to:

- attend to their own interests, needs, and abilities;
- integrate new knowledge through quiet reflection;
- assume responsibility in directing their own learning.

Work with other children provides opportunities to:

- develop sensitivity to the views, feelings, and safety of others;
- develop communication skills;
- gain experience in planning, organizing, making decisions, and solving problems;
- experience a variety of ways of interacting with others;
- share ideas, feelings, and achievements;
- clarify, refine, and consolidate learning through discussion.

Resources

Children must have the opportunity to interact with materials, people, places, and the outdoor environment.

Materials that are a part of the learning environment must be durable and safe and encourage manipulation appropriate to the learner and the activity or task. Many of these materials should be available at all times. Learning happens naturally as children interact with materials common to their environment, but unusual or unfamiliar materials can also enhance and extend learning.

It is important that all children have access to materials, but it is not always necessary to have a class set. Grouping children at different activities is one way to use resources efficiently. Furthermore, in a flexible learning environment, children may achieve similar objectives through different learning experiences.

In a rich classroom environment with many interesting resources, safety must be addressed in accordance with Ministry of Education and school board policies. Even the use of common materials such as sand and water must be guided by safety procedures (e.g., maintaining sanitary conditions, establishing safe routines). Where plants and animals are used in the learning environment, teachers should attend to the considerations outlined in Appendix B.

The learning resource librarian and materials in the school library resource centre play key roles in providing print and non-print resources to support hands-on experiences. For many school boards, an effective means of sharing resources is through the establishment of a kit loan program.

Human resources play an important role in the planning and facilitation of science experiences. They may include teachers, children, principals, teacher-librarians, school board resource staff, parents, and community members with expertise and interest in science.

The learning environment must extend beyond the classroom and the school. Experiences at places such as museums, zoos, farms, and science centres provide first-hand encounters with science. The schoolyard and local streams, ponds, meadows, and forests offer opportunities for experiencing, understanding, and appreciating the natural environment.

Computers

Computers are a recent addition to the learning environment. They are useful in providing extensions of and support for science learning. They also help overcome restrictions of cost, time, accessibility, and safety through simulations of expensive, time-consuming, and dangerous activities. Computers should not, however, be regarded as a primary means of delivering science education or as a replacement for the direct investigation of natural and physical phenomena.

It is valuable for children to become knowledgeable and creative in their use of computers to:

- record, store, manage, analyse, share, and retrieve raw data;
- report results of investigations and experiments using words, numbers, or graphic representations;
- extend their thinking skills and creative abilities;
- communicate with peers over distance;
- accommodate special intellectual and physical requirements.

Children learn about technology by exploring and investigating simple materials and devices that are part of their everyday environment (e.g., adhesives, erasers, pencils, toys, pencil sharpeners). In addition, the use of more complex technologies such as computers gives children some awareness of the role of technology in society.

Balance

Several aspects of the teaching/learning environment need to be balanced to meet what the teacher judges to be the needs, abilities, and interests of the children. A well-balanced program will include:

- experiences related to attitude, skill, and knowledge development;
- activities that cater to a full range of abilities, exceptionalities, and learning styles;
- activities that are teacher initiated and directed and activities that are child initiated and directed;
- experiences for the whole class, small groups, and the individual child;
- opportunities for divergent and convergent thinking;
- experiences in life, earth and space, and physical sciences;
- teacher, peer-group, and self-assessment.

Integration

The notion of integration implies a curriculum "characterized by learning which is synthesized across traditional subject lines, and learning experiences which are arranged in order to be mutually reinforcing."[4] An integrated program, then, is one in which the child has the opportunity to pursue learning in a holistic way, without the restrictions that may be imposed by subject-area boundaries.

In a teaching/learning environment where children are encouraged to explore freely, ask questions, and seek solutions, integration of science with other subjects will happen naturally. When children experiment with mixing the primary colours in order to discover which combinations produce which other colours, science is happening. Science is also happening when children choose freely from a variety of common materials to construct a musical instrument of their own design. In these and many other instances, science provides the starting point for integrated learning.

Language

Scientific activities encourage the use of language. During such activities, children listen, talk, read, write, view, and present as they refine, clarify, consolidate, and share their learning.

Children's direct observation and manipulation of concrete materials during science investigations provide subjects for discussion and opportunities to practise classifying and ordering. Discussion and classification, in turn, lead to naming, describing, sequencing, charting, graphing, and using qualitative and quantitative words and images. The investigations are often enhanced and extended through reading, listening, and viewing.

Learning opportunities that encourage children to talk about science observations and discoveries in their own words, as well as in scientific language, help them to acquire a variety of expressive language skills. These skills include asking questions, describing, explaining, writing, clarifying, and presenting.

4. Ministry of Education, Ontario, "Education in the Junior Division: A Look at Forty-two Schools", Provincial Review Report, no. 5 (Toronto: Ministry of Education, Ontario, 1985), p. 5.

Play

For children, play is a natural way of learning. Through play, children can explore, ask questions, seek solutions, invent, construct, and solve problems. Play contributes to the development of the attitudes, skills, and knowledge prescribed in this document.

Children's early play is unconstrained by reality, evaluation, and judgement. Exploration at the Primary level with materials such as toy cars, blocks, sand, and water leads to more sophisticated investigations at the Junior level. For example, in the Primary Division, children might use their blocks to build garages and roads for their toy cars or classify the blocks and cars by size or colour. In the Junior Division, they might investigate the relationships between the heights of ramps they have built and the distances travelled by a car when it is released from the top of each ramp.

Whether children are exploring freely or participating in a more structured experience, opportunities for meaningful interaction with their teacher are vital to the learning process. Play experiences are richer in an environment where respect for the rights of others is encouraged and care for materials is routine.

Problem Solving

In problem solving, attitudes, skills, and knowledge are used in concert. Problem solving is embodied in play and facilitated by questions such as: "What do we want to know?" and "How can we find out?" Problem solving is often described as a series of steps, the content of which varies depending on the nature and level of the inquiry. The model included in Appendix C is presented as a sample for teacher reference. Variations of the model or completely different models can be used by the teacher as a framework for guiding and facilitating the progress of children through their explorations and investigations.

Attitudes, Skills, and Knowledge

Each child brings to the learning environment a background of attitudes, skills, and knowledge that is subject to change and growth through learning opportunities involving the elements of science and technology.

Attitudes

While individuals develop personal attitudes about themselves and their environment, there are also widely shared attitudes,[5] some of which are conducive to scientific inquiry. By modelling these appropriate attitudes, teachers can encourage children to apply the knowledge and skills of science in responsible and positive ways. Specifically, the learning environment provided for science should nurture:

- concern and care for the environment;
- respect for living things;
- consideration for others;
- open-mindedness;
- objectivity and accuracy;
- thoroughness and perseverance;
- safety-mindedness;
- curiosity and risk taking.

5. Ministry of Education, Ontario, *Personal and Societal Values: A Resource Guide for the Primary and Junior Divisions* (Toronto: Ministry of Education, Ontario, 1983).

Skills

The skills children learn in the course of gathering and applying information are important to the learning process in all areas of the curriculum, including science. By using these skills in reasoned and intuitive ways, children make sense of their experiences and of the world around them.

The skills developed through science include:

- observing: using the senses to gather information first-hand;
- classifying: sorting objects, events, or conditions according to a pattern or scheme devised by the observer;
- seriating: ordering objects, events, or conditions (e.g., shortest to longest, lightest to heaviest);
- communicating: receiving and expressing information through listening, speaking, writing, reading, viewing, and presenting;
- measuring: using both non-standard units (e.g., hand spans, paces) and standard units (e.g., minutes, metres, kilograms, degrees Celsius) to develop quantitative descriptions;
- inferring: making assumptions about an attribute that has not been directly observed;
- predicting: using information to make decisions about what may happen;
- hypothesizing: advancing a possible explanation based on a number of observations and inferences;
- experimenting: designing and carrying out investigations to test predictions or hypotheses;
- controlling variables: discovering and manipulating conditions that affect the results of an experiment;
- interpreting: developing conclusions about information gathered;
- making models: constructing representations of things that are inaccessible using things that are readily available (e.g., a paper airplane).

In addition, children need time and opportunities to develop the physical skills required to use scientific equipment. This equipment includes rulers, hand lenses, balances, and microscopes.

Although all of the above skills may be used by children throughout the Primary and Junior Divisions, the more complex skills of interpreting, hypothesizing, experimenting, and controlling variables are more appropriately emphasized in the Junior Division and beyond.

Each child's development of the skills of scientific inquiry will be unique. The ministry support documents *Shared Discovery*[6] and *Science in the Primary and Junior Divisions*[7] can, however, help teachers to frame general expectations for skill development.

Knowledge

As children acquire information, they build concepts and make generalizations. The knowledge gained through one learning experience affects other endeavours, providing children with a base from which to acquire new knowledge and skills and giving them the confidence to seek solutions to new questions.

Although the choice of appropriate learning opportunities for children in the Primary and Junior Divisions is based on broad concepts, it is important that the experiences grow from the perspectives of the children rather than from the concepts themselves. Opportunities involving wind-up toys, flashlights, or magnets, for instance, will contribute to a growing concept of energy without requiring a precise definition of the concept.

The learning opportunities provided for science must help children learn about themselves and their immediate environment. This learning will enhance their understanding of broad concepts, including the following:

- energy
- space
- time
- matter
- community
- life
- change
- growth
- interrelationships
- technology
- conservation

In addition, the learning opportunities provided for science must give children some insight into the nature of science by making them aware of:

- the various skills used in science (outlined on the page opposite);
- the equipment appropriate to science activities (e.g., magnifiers, which enable us to extend our sense of sight);
- the vocabulary and terminology associated with first-hand science experiences;
- safety procedures and equipment;
- the roles of the various skills in scientific problem solving;
- the potential and limitations of science and technology.

6. Ministry of Education, Ontario, *Shared Discovery: Teaching and Learning in the Primary Years* (Toronto: Ministry of Education, Ontario, 1985).

7. Ministry of Education, Ontario, *Science in the Primary and Junior Divisions* (Toronto: Ministry of Education, Ontario, 1983).

Learning Opportunities

Attitudes

- Concern and Care for the Environment
- Respect for Living Things
- Consideration for Others
- Open-Mindedness
- Objectivity
- Accuracy
- Thoroughness
- Perseverance
- Safety-Mindedness
- Curiosity
- Risk Taking

Skills

- Observing
- Classifying
- Seriating
- Communicating
- Measuring
- Inferring
- Predicting
- Hypothesizing
- Experimenting
- Controlling Variables
- Interpreting
- Making Models
- Manipulating Equipment and Materials

Knowledge

- Energy
- Space
- Time
- Matter
- Community
- Life
- Change
- Growth
- Interrelationships
- Technology
- Conservation

Learning Opportunities

The learning opportunities identified for the Primary and Junior Divisions (Junior Kindergarten to Grade 6) should help children to develop appropriate attitudes, skills, and knowledge. The descriptions that follow indicate the kinds of experiences that children should have, rather than specific learning outcomes. The wording of the opportunities for the Junior Division does not always indicate obvious growth from the Primary Division. In such instances, it should be understood that growth will be embodied in the child's response to the experience. It is the professional responsibility of the teacher "to ensure learning at a level and rate that are in keeping with individual abilities".[8] "The Complexities of Childhood" is a resource chart that teachers can use as a guide to fulfilling this responsibility.[9]

Among the learning opportunities that follow, the ones that emphasize technology are printed in italics. The purpose of the technological experiences is to encourage awareness of and involvement with simple technologies rather than acquisition of detailed knowledge.

Experiences with life, earth and space, and physical sciences must provide opportunities for the children to:

- gather information using a variety of communication techniques;
- develop and use a variety of techniques for recording, reporting, and representing experiences with science (e.g., discussion, pictures, charts, graphs, drama, stories, models, newsletters);
- use a variety of technologies to gather and share information during science experiences (e.g., computer, microscope, measuring equipment, camera);
- develop concern for their own safety and the safety of others;
- develop safe practices in the use of equipment during science experiences;
- recognize science as it is happening in their learning environment;
- develop an awareness of the involvement of Canadians in science and technology.

8. *The Formative Years,* p. 5.

9. Ministry of Education, Ontario, "The Complexities of Childhood", Resource Chart (Toronto: Ministry of Education, Ontario, n.d.).

Life Science

Primary Division

Children shall have opportunities to:

- demonstrate concern and care for the environment and respect for all life (e.g., by maintaining bird feeders, planting bulbs, using litter receptacles);
- *become aware of some of the machines and tools that are used to maintain a safe, clean environment (e.g., garbage truck, broom, snowplow, rake, furnace filter);*

- observe and describe a wide variety of living things;
- investigate the similarities and differences among living things (e.g., body parts, mobility, coverings);
- *identify devices that imitate animal characteristics (e.g., snowshoes, swimming flippers);*

Junior Division

Children shall have opportunities to:

- demonstrate concern and care for the environment (e.g., by planning and conducting a schoolyard beautification project, assuming responsibility for the care of classroom plants or animals);
- *investigate ways to care for the environment (e.g., recycling materials, treating sewage, reusing bottles);*

- observe, describe, and compare a wide variety of plants and animals common to the immediate environment;
- *use equipment to observe plants and animals (e.g., magnifier, low-powered [40x] microscope);*

Life Science

Primary Division	Junior Division
– develop and use their own criteria for classifying common living things;	– develop their own simple systems for classifying plants and animals;
– *classify things used by people according to the natural materials from which they are made (e.g., blocks, desks, and toys made from wood);*	
– observe the growth and development of common animals and common plants;	
– *extend their senses by using equipment (e.g., binoculars, magnifiers);*	
– care for an animal and a plant over a period of time;	– investigate the life cycles of some common plants and animals;
– *use materials to replicate a natural environment (e.g., aquarium, terrarium, ant farm, planter, incubator, greenhouse);*	– *use materials to replicate a natural environment (e.g., aquarium, terrarium, hydroponic garden);*
– explore ways in which living things adapt to their natural environment in order to survive (e.g., migration, hibernation, camouflage);	– observe and describe plants and animals peculiar to a particular habitat (e.g., pond, woodlot, schoolyard, forest);
	– observe the ongoing process of change in a natural community;

Life Science

Primary Division	Junior Division
– investigate the needs of animals and plants (e.g., for water, food, shelter, light, air, rest, physical activity) and how they are met;	– design and perform an experiment involving seed germination or plant growth;
– observe ways in which animals behave and interact;	– identify relationships among living things (e.g., simple food chains, behaviour, the parasite-host relationship); – *investigate ways in which people affect plant and animal life (e.g., by using fertilizers or pesticides, developing a subdivision, establishing a wildlife preserve, gardening);*
– investigate plant and animal products (e.g., fish, fruit and vegetables, grain, beef, dairy products, lumber, paper); – *become aware of some of the machines that are used in cultivating, harvesting, processing, storing, or transporting plant and animal products (e.g., garden fork, tractor, milking machine, chain saw);*	– investigate human dependence on plants and animals (e.g., for food, clothing, oils, building materials); – *identify and describe several machines used in cultivating, processing, harvesting, storing, or transporting plant or animal products (e.g., farming equipment, lumbering equipment);*
– explore the role of their senses in gathering information; – *become aware of equipment that extends our senses (e.g., eyeglasses, hearing aid, smoke detector, stethoscope, balance) and use it when appropriate;*	– develop an awareness of the human body, including its needs, its systems, and its systems' functions; – *identify – and examine, if appropriate – devices that aid in the observation and care of the human body (e.g., stethoscope, X-ray machine, thermometer, sphygmomanometer);*

Primary Division

- develop an awareness of their bodies and bodily needs;
- *become aware of equipment that assists disabled people (e.g., wheelchair, ramp, prosthesis, brailler) and try out such equipment when appropriate;*
- *become aware of tools and instruments they use in health care and nutrition (e.g., toothbrush, medical thermometer).*

Junior Division

- develop an awareness of human diseases and disabilities;
- *become aware of equipment that assists disabled people (e.g., wheelchair, crutches, casts, ramp, prosthesis, brailler) and use such equipment when appropriate.*

Life Science

Earth and Space Science

Primary Division	Junior Division
Children shall have opportunities to:	Children shall have opportunities to:
– play with water and sand, using toys (e.g., funnel, siphon, water wheel, shovel, pail, sieve, containers);	– design and conduct experiments involving the properties and functions of particles (e.g., sand, sugar, salt) and liquids (e.g., water, oil, vinegar);
– discover some of the properties of water (e.g., takes the shape of any container, freezes);	
– *experience some ways in which mechanical devices are designed to accommodate and use the properties of water (e.g., water pump, garden hose, sink overflow hole, siphon, plant mister, water wheel, ice auger);*	
– explore the phenomena of sinking, floating, absorbing, dissolving, etc., with a variety of common materials (e.g., sponge, boat, anchor, wax paper, sugar, wood);	
– explore the concepts of water pressure, displacement, movement, and propulsion;	
– discover some of the functions of water (e.g., sustaining life, cooling, transporting, cleaning);	
– discover some of the properties of wet and dry sand;	
– *explore some of the uses of sand (e.g., concrete, sand timer, sand castles);*	
	– investigate at least one of the following from the local environment: rocks and minerals, fossils, soils;
	– *use devices appropriate to the investigation of rocks and minerals, fossils, or soils (e.g., rock tumbler, hand lens, sieve);*

Earth and Space Science

Primary Division	Junior Division
– observe and describe weather conditions and changes (e.g., snow, rain, changes in temperature or cloud cover);	– observe and describe a variety of weather conditions and suggest ways of predicting weather;
– *use tools to make observations about the weather (e.g., thermometer, rain gauge, weather vane);*	– *design, construct, and use simple weather instruments (e.g., wind vane, rain gauge, anemometer, barometer, hygrometer);*
– observe that weather follows annual patterns and that the patterns can be classified according to seasons;	– identify ways in which weather conditions affect their lives;
– *classify materials and tools that people use to adapt to various weather conditions (e.g., toboggan and sleigh for snowy weather; boots, umbrellas, and raincoats for wet weather);*	– *become aware of devices that people use to adapt to various weather conditions (e.g., foghorn, lightning rod, snowplow, air conditioner, raincoat) and examine these devices when appropriate;*
	– *use appropriate materials to explore the nature and movement of air (e.g., pinwheel, fan, kite);*
– observe and describe a variety of indicators of seasonal change;	
– predict change on the basis of observations of the environment (e.g., buds precede leaves and flowers, clouds precede a storm);	
– experience activities that encompass both long and short intervals of time;	– estimate and measure time to the nearest hour, minute, and second;
	– *design, construct, and calibrate a device to measure units of time (e.g., sand clock, water clock, pendulum);*
	– match events to appropriate units of time (e.g., measure vacations in weeks or days, performance on 100-m sprint in seconds);
	– *identify and use devices for measuring particular units of time (e.g., stopwatch, clock, watch, calendar);*

Earth and Space Science

Primary Division	Junior Division
– identify predictable events in their lives (e.g., birthdays, holidays);	– observe cyclical occurrences in their lives and in the natural world (e.g., phases of the moon, activity/rest cycles, feeding cycles, growth rings in a tree);
– *use devices that indicate predictable events in their lives (e.g., calendars, school bells, alarm clocks);*	
– develop time lines to track and record observed events in science (e.g., plant growth, changes of state, their own life patterns);	– develop time lines to track and record observed events of a scientific nature (e.g., changes of state, plant growth, experimental processes);
	– *identify and use devices for tracking and recording scientific events (e.g., tape recorder, camera, calendar, computer);*
	– estimate and measure distances and the time that objects take to traverse them;
	– use time as a variable in an experiment;
– observe and describe hourly changes in the pattern of a shadow and the relationship of these changes to the sun;	– develop an awareness of the movement of the earth that results in day and night and the seasons;
– *use devices to note the apparent movement of the sun (e.g., a flagpole, a post, a simple sundial);*	
– make simple observations about the sun, moon, earth, and stars in space;	– develop an awareness of the earth, moon, and sun and, when appropriate, observe phenomena such as eclipses and phases;
– *develop an awareness of devices that help people learn about the moon and other bodies in outer space (e.g., telescope, binoculars, spacecraft) and use them when appropriate.*	
	– develop an awareness of challenges related to travel in space (e.g., life support, movement);
	– *investigate products that people use to deal with the challenges of space travel (e.g., freeze-dried food, pressurized ballpoint pens).*

Physical Science

Primary Division

Children shall have opportunities to:

- *play with construction materials (e.g., blocks, boxes, tubes, straws);*
- observe, describe, and collect a variety of materials (e.g., plastic, wood, steel, paper, rubber, magnets);
- observe and describe simple changes (e.g., snow to water, water to ice, batter to cake, corn kernels to popcorn);
- *become aware of devices that produce changes (e.g., steam iron, vaporizer, freezer, clothes dryer, humidifier, corn popper) and use them when appropriate;*
- experiment with the interactions of various materials (e.g., using magnets, applying adhesive materials, mixing things);

Junior Division

Children shall have opportunities to:

- *design and build structures (e.g., bridges, towers, buildings) using common materials (e.g., cards, toothpicks, straws, blocks);*
- investigate the physical properties of one or more materials (e.g., absorbency of paper towels, expansion of solids, solubility);

Physical Science

Primary Division	Junior Division
– classify and seriate common materials according to their own criteria;	– design and perform an experiment in which a particular property is compared and measured in two or more objects (e.g., strength in plastic garbage bags, bounce in rubber balls);
– classify and seriate common materials according to established criteria (e.g., texture, size, mass, flexibility, volume, odour, colour, hardness);	– *use appropriate measuring devices employing standard and non-standard units (e.g., balance, metre stick, pop can, spring scale, stopwatch);*
– *use appropriate devices to measure, employing standard and non-standard units (e.g., balance, metre stick, pop can, timer, pendulum);*	– *design, construct, and calibrate a measuring device (e.g., thermometer, balance, force meter);*
	– explore and experiment with ways in which a material can be changed naturally (e.g., by rust, decay, erosion, fading of colour);
	– *identify products and processes used to preserve materials (e.g., rust inhibitors, paint, drying, galvanizing, freezing);*
– explore and experiment with ways to move objects by pushing and pulling;	– design and perform an experiment to explore a cause-and-effect relationship (e.g., factors that affect the rate at which a pendulum swings, the effect of moving the fulcrum of a teeter-totter;
– *use devices that require pushes and pulls to move them (e.g., spinning top, door, toy truck);*	– *construct devices incorporating one or more simple machines (lever, pulley, wheel and axle, inclined plane, wedge, screw) and experiment with them;*
	– *identify and use everyday devices that incorporate simple machines (e.g., scissors, teeter-totter, block and tackle, crane, ramp, jar lid, manual pencil sharpener, jack);*
– investigate friction using common materials (e.g., sandpaper, wax, grease, water, eraser);	

Physical Science

Primary Division	Junior Division
– observe evidence of energy in the immediate environment (e.g., toy cars moving, kites flying, pinwheels whirling, light bulbs giving off heat, magnets moving objects);	– explore the characteristics and properties of one or more forms of energy (e.g., electricity, sound, light, magnetism, heat, mechanical energy, chemical energy);
– *experiment with some devices that make use of properties of various forms of energy (e.g., mirror, prism, kaleidoscope, musical instruments, megaphone, wind-up toys);*	– *identify devices or substances that involve a particular form of energy (e.g.,* electrical – *blender, toaster, stoplights, Christmas tree lights;* sound – *bells, buzzers, musical instruments;* light – *mirror, eyeglasses, prism;* magnetic – *refrigerator door, crane lift;* heat – *school furnace, solar cooker;* mechanical – *wind-up toys, manual can opener, bicycles;* chemical – *rock salt, baking ingredients, household solvents);*
– *use devices that employ various forms of energy (e.g., pencil sharpeners, windmills, flashlights, toys, human arm);*	– explore the conversion of energy from one form into another (e.g., electricity into heat, mechanical energy into sound);
	– *identify materials or objects in which the conversion of energy occurs (e.g., solid fuel, kettle, musical instrument);*
– develop awareness of their role in the wise use of energy;	– demonstrate concern and care for the environment (e.g., repair dripping faucet; collect paper, aluminum cans, or bottles for recycling);
– *identify devices that may help conserve energy (e.g., light switch, thermostat, doors and windows, insulation, water tap).*	– *identify devices used to conserve energy (e.g., time switch, tap, showerhead flow restrictor, thermostat);*
	– demonstrate their role in the wise use of energy.

AGAZINES

Science From Junior Kindergarten to OACs

The learning opportunities described for the Primary and Junior Divisions encourage the exploration, from the children's perspective, of a variety of areas in science and technology. The range of opportunities ensures a background of experiences and exposure to the concepts outlined in this document while fostering investigations that are relevant to the children. At this level, science is seen, not as a separate subject, but as one component of a balanced and integrated program.

During the Intermediate Division, the experiences of the students are interrelated through an emerging understanding of the concepts associated with scientific study. Although the topics of investigation continue to be relevant to the students, the activities are chosen more particularly to focus on the development of specific concepts. At this level, science emerges as a distinct subject, but the mosaic of biology, chemistry, physics, and environmental science allows students to experience the reality that scientific processes and principles cross the artificial boundaries between the disciplines.

The more specific and detailed investigations of the Senior Division require the subdivision of science into courses corresponding to the various disciplines. Courses in biology, chemistry, physics, geology, environmental science, technological science, and science in society provide students with opportunities to study fields more closely corresponding to the divisions of science and technology encountered outside the school.

Assessment and Evaluation

Assessment by the teacher provides information required to evaluate the effectiveness of the program and the suitability of materials to the program and to the needs and abilities of the children. This information is necessary for both day-to-day and long-term planning by the teacher. Assessment by the teacher is also used to monitor children's growth in skills, knowledge, and attitudes and to provide information to the children, the parents, and the teacher.

Observation of children's activities is essential for making judgements about how the children:

- perform specific tasks;
- respond to open-ended investigations;
- function individually and as members of a group;
- approach an investigation that requires them to initiate activity, gather information, and report;
- use skills (e.g., observing, classifying) in science-related activities;
- understand a particular concept or generalization.

At times an activity may be designed specifically for observation. Such an activity requires that children demonstrate a skill or an understanding by manipulating real objects. The products of children's activities, too, give teachers a view of children's development, and they provide concrete evidence of children's progress that can be shown to parents.

Self-assessment helps children to develop a sense of responsibility for their own learning. It encourages children to reflect on their growth and learning, giving them a sense of where they have been, where they are, and where they are going. Furthermore, self-assessment itself is a valuable skill, and children can benefit from practice in it.

When self- and peer assessment occur under the teacher's guidance, they provide children with responses to their work besides those of the teacher and enhance their appreciation of the roles of the various individuals in a group. Through modelling and coaching, teachers can help children to provide constructive and supportive feedback to themselves and to one another.

Maintaining a record of assessment results assists teachers in determining children's needs, assessing program effectiveness, and preparing meaningful reports for children and parents. Methods of recording include rating scales, charts and graphs, individual and group profiles, anecdotal comments, forms for peer and self-evaluation, and checklists. Supporting documentation should include a file of sample work for each child.

An Ontario Assessment Instrument Pool (OAIP/BIMO) is being prepared for the science component of the program in the Junior Division. It will assist in the development of a balanced approach to assessment. Items in the pool will support observational techniques and assessment of oral and written responses. In addition, the pool will serve as a source of practical science activities that can be incorporated into the classroom program.

COME AND READ

Responsibility for Implementation

The Ministry of Education, school board officials, principals, and teachers share the responsibility for meeting the expectations for the science curriculum outlined in this policy statement. All participants should ensure that they:

- are thoroughly familiar with the policy;
- foster professional development and support in-service programs;
- promote community awareness of the importance of the science component of the curriculum;
- involve community members in the implementation of the curriculum, whenever appropriate.

The Ministry of Education

The Ministry of Education is responsible for:

- establishing a common framework of goals and aims for education;
- developing and articulating curriculum policy;
- initiating the delivery of the policy;
- reviewing the policy and its implementation.

School Board Officials

The role of school board officials, including supervisory officers and consultative staff, is to provide:

- leadership in various aspects of the implementation process, including curriculum and professional development;
- opportunities for co-operative planning;
- programs congruent with ministry policy;
- resources, including appropriate facilities.

Principals

Principals provide leadership in planning with staff members a program that is suited to the particular children for whom they are responsible. Principals meet this obligation by:

- assisting in the provision of materials, facilities, and human resources;
- encouraging shared management of implementation so that all staff have input into, and a sense of ownership of, the process;
- monitoring implementation;
- providing opportunities for, and participating in, co-operative planning.

Teachers

The teacher's plan of action for program delivery should focus on:

- co-operating with other staff members in planning a program that implements policies developed by the Ministry of Education and by the local school board;
- enlisting the support of teacher-librarians for such things as planning, team teaching, and development of resource-based learning;[10]
- ensuring that the program is in keeping with children's needs and abilities;
- identifying and using appropriate resources (people, places, and materials).

10. See Ministry of Education, Ontario, *Partners in Action: The Library Resource Centre in the School Curriculum* (Toronto: Ministry of Education, Ontario, 1982).

PROJECT

Appendixes

Appendix A: The Teacher's Role

Listed below are some questions that teachers can use to help themselves implement the spirit of *Science Is Happening Here.*

How do I:

- facilitate the development of attitudes, skills, and knowledge?
- encourage children to identify and pursue their own questions and interests?
- show respect and support for the children?
- encourage children to investigate science in the outdoors?
- participate along with children in exploration and investigation?
- acquaint children with the care and proper handling of living things?
- facilitate children's working alone and in a variety of combinations (i.e., in small and large groups)?
- model safe practices and communicate safety expectations to the children in accordance with school board and Ministry of Education policies?
- encourage the children to observe, question, discuss, and experiment?
- invite children to use their senses to examine, manipulate, and interact with their environment?
- facilitate the development of language through science experiences?
- assist children in recognizing that they are doing science?
- use appropriate resources (materials, places, people) in the planning and maintenance of the learning environment?
- maintain a flexible learning environment that will accommodate the needs, abilities, and interests of all the children?
- achieve a balance between child-initiated and teacher-initiated activities?
- ensure that assessment and evaluation strategies address all aspects of the program?

Appendix B: Living Things in the Classroom

Many learning opportunities are enhanced by the presence of living things. To ensure that the inclusion of living things in the classroom environment is a positive experience, teachers must follow relevant school board policies and attend to the following requirements for the care of plants and animals:

- Housing facilities provided for living things must ensure the safety and protection of both the children and the plants or animals.
- Plans should include appropriate feeding schedules, provision for care on weekdays, weekends, and holidays, and strategies to accommodate possible offspring. They should also include procedures to be employed when the living things are no longer required.
- Issues of hygiene, infectious diseases, allergies, bites, smells, etc., should be discussed with principals, parents, and children.
- Animals such as rats, hamsters, gerbils, guinea pigs, and fish are very useful but should be purchased from accredited dealers who can supply disease-free stock.
- Invertebrates such as snails, spiders, caterpillars, sow bugs, earthworms, and mealworms are practical for the classroom because they are easily obtainable, do not transmit disease, can be returned to their habitat, and require less space and specialized equipment than vertebrates.
- Wild vertebrates should not be brought into the schools.
- Micro-organisms should be cultured only in sealed containers and never on agar or gelatin plates.
- Children should be instructed never to put any plant material into their mouths. Many plants have poisonous or irritating parts, and some fungi are dangerous.
- Washing hands before as well as after handling animals and plants should be normal classroom procedure. Children should use polythene gloves, which are inexpensive and disposable, when cleaning cages.
- Monkeys, wild mammals, turtles, and such birds as budgerigars and parrots should never be kept in the classroom because they can transmit dangerous diseases.
- Students may handle chicken or duck eggs during hatching, but after doing so they should wash their hands thoroughly, as the shells may contain bacteria. Newly hatched chickens and ducklings should not be kept in the classroom for long periods of time.
- Teachers should be prepared to deal with the sickness or death of classroom animals. They should have the address and telephone number of a nearby veterinarian or a local branch of an animal welfare agency. Professional advice should be sought when it is needed.[11]

Information about keeping animals in the classroom may also be obtained from:

The Director
Animal Industry Branch
Ministry of Agriculture and Food
Guelph Agriculture Centre
Box 1030
Guelph, Ontario
N1H 6N1

Youth Science Foundation
Animal Care Committee
151 Slater Street, Suite 302
Ottawa, Ontario
K1P 5H3

11. The material in this section has been adapted from *Science in the Primary and Junior Divisions*, pp. 9-10.

Appendix C: A Problem-Solving Model

The model presented here is one of many that can be used to solve problems. Real-life problem solving often approximates such a model, but during an investigation ongoing evaluation may suggest the need to retrace steps and repeat some or all of the preceding stages. Such repetition may be necessary in order to clarify the problem further before proceeding.

STAGE	DESCRIPTION	SOME FACILITATING QUESTIONS
Exploring	Children learn by using their senses to explore materials and events. As they do so, they identify interests and formulate questions.	What do we see? What do we hear? What is happening?
Inquiring	Children ask questions of themselves and others to clarify an issue or define a problem related to their interests.	What questions could we ask to find out what we want to know (e.g., Which one is strongest? Why did the bulb light? When . . . ? What . . . ? How . . . ? Which . . . ?)?
Predicting	Children think of a range of possible outcomes to their investigations.	What do we think? How will we know?
Planning and Collecting	Through planned activities, children gather information about each possible outcome. One way of collecting information is by designing and carrying out experiments.	How can we find out? What can we do? What will we need? Where should we look? Whom should we ask? How will we know?
Deciding	On the basis of the information gathered, children select the most appropriate solution(s).	What did we learn? What do we think now? What are we going to do now?
Communicating	Children choose the best way to present their findings. (Making this decision involves another cycle of problem solving.)	With whom should we share? Why should we share? What should we share? How can we share?
Evaluating	Children check the merits of their conclusions and the effectiveness of their problem-solving techniques. (Evaluation by the children should occur throughout the sequence as well as at the end.)	Did we find out what we wanted to? Could we have done it differently?
Applying	Children seek examples, from their own experience, that illustrate their discoveries.	How is this the same as . . . or different from . . . ? What other questions could we ask?

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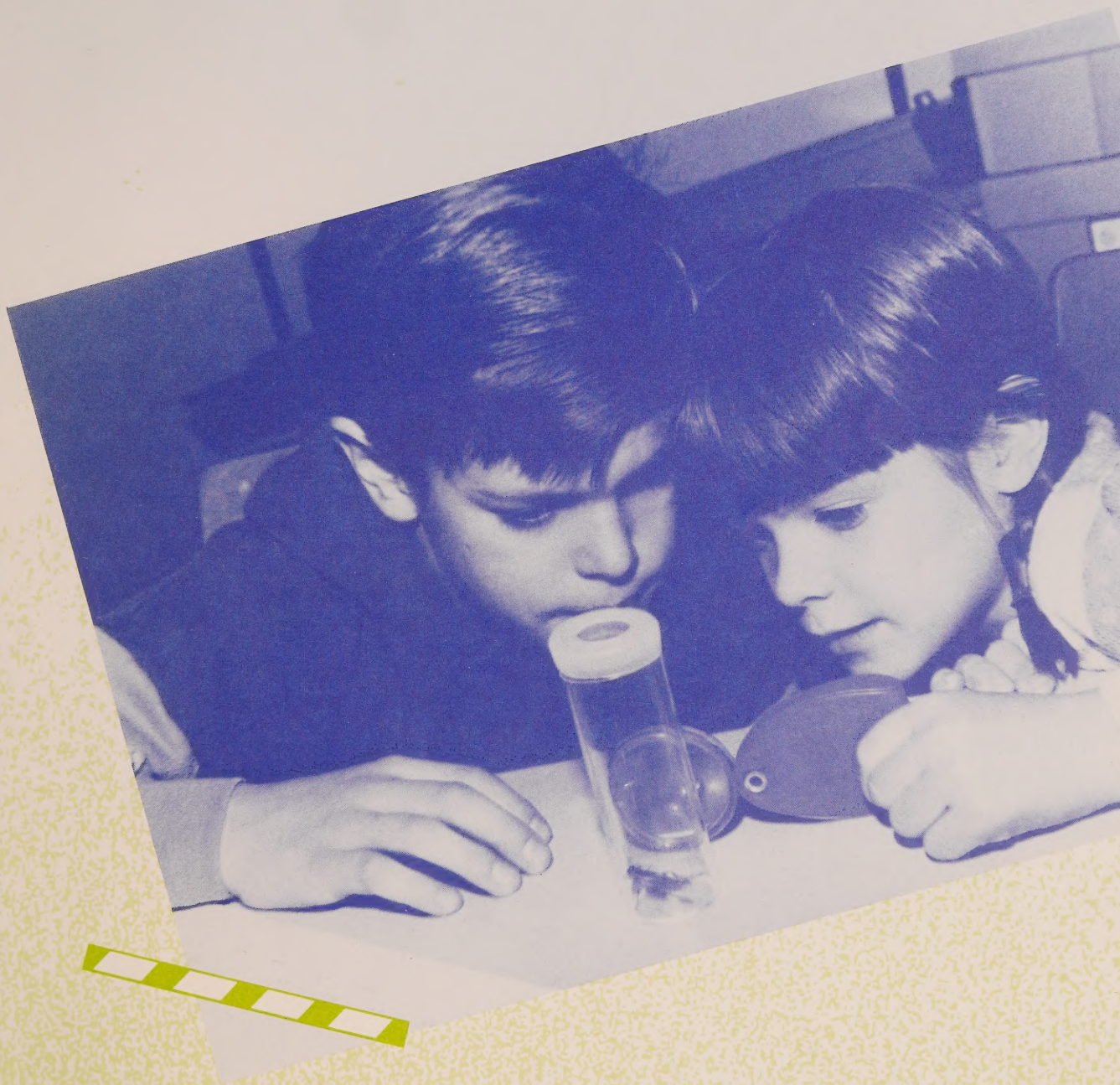
KEY

CAPE	Consultants'/Co-ordinators' Association of Primary Educators
COEO	Council of Outdoor Educators of Ontario
OAEAO	Ontario Association of Education Administrative Officials
OSLA	Ontario School Library Association
OSTC	Ontario School Trustees' Council
OTF	Ontario Teachers' Federation
SCCAO	Science Co-ordinators' and Consultants' Association of Ontario
STAO	Science Teachers' Association of Ontario



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